

4.10 Through 4.13 Appendices J through M

HQ asked for updated references, so presumably they want them added. May we add a new section titled added by reviewer suggestion? 1) To shorten the time of searching if they are already there, and 2) to make clear we may not have looked at them? (Actually I do have a number of them, even past our cutoff date)

Articles cited in each section of the report are limited to those actually used in that section. This will not be changed.

Add to front of Bibliography something like the following: In general publications included in the bibliography were limited to peer reviewed articles or specific technical presentations. Several of the suggested articles appear in non-peer reviewed publications, specifically Science and Earth Magazine. Geology is not clear, as to whether it is peer reviewed or not, even though published by GSA. From the publication websites:

- Earth Magazine: Please be aware that EARTH is not a peer-reviewed journal, but rather an opportunity to communicate with the broad public.
- Science: Only some of the submitted papers are reviewed in depth.
- Geology: published since 1973, features rapid publication of about 23 refereed short (four-page) papers each month. Articles cover all earth-science disciplines and include new investigations and provocative topics

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Comments by Jeff Bull, Oil/Gas Industry

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| Class | Jeff Bull <i>Oil/Gas Industry</i> | EPA reviewer discussion notes: Consensus |
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Comments by Robin McGuire, Consultant

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| Class | Robin McGuire <i>Consultant</i> | EPA reviewer discussion notes: Consensus |
| No | Appendix K: Subject Bibliography A reference that should be mentioned is the following: W.L. Ellsworth, "Injection Induced Earthquakes," Science, 12 July 2013: Vol. 341 no. 6142 | Science is not a peer reviewed journal. |

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Comments by Craig Nicholson, Academia

| Class | Craig Nicholson <i>Academia</i> | EPA reviewer discussion notes: Consensus |
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| add | <p>Appendix K: Subject Bibliography</p> <p>Committee on Induced Seismicity Potential (2012) in Energy Technologies, Induced Seismicity Potential in Energy Technologies, National Research Council, Washington, DC;</p> <p>http://dels.nas.edu/Report/Induced-Seismicity-Potential-Energy-Technologies/13355.</p> <p>Keranen, K. M., H. M. Savage, G. A. Abers, and E. S. Cochran (2013), Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injection and the 2011 Mw 5.7 earthquake sequence, <i>Geology</i>, G34045.1, doi:10.1130/G34045.1.</p> <p>McGarr, A., 2014, Maximum magnitude earthquakes induced by fluid injection, <i>Journal of Geophysical Research Solid Earth</i>, v.119, doi: 10.1002/2013JB010597.</p> | <p><u>Already included</u></p> |
| no | <p>Ellsworth, W.L., 2013, Injection-induced earthquakes, <i>Science</i>, v.341, 1225942, doi: 10.1126/science.1225942, p.142.</p> <p>Zoback, M.D., 2012, Managing the seismic risk posed by wastewater disposal. <i>Earth Magazine</i> v.57, p.38–43</p> | <p>See above, re Science and Earth-- Not peer reviewed</p> |

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Comments by Kris Nygaard, Oil/Gas Industry

| Class | Kris Nygaard <i>Oil/Gas Industry</i> | EPA reviewer discussion notes: Consensus |
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| add | Appendix K: Subject Bibliography 1. Page K-2, Educational Websites on Seismicity Suggest including link to the USGS Earthquake Hazards Program "ShakeMap" internet site. ShakeMap sites provide near-real-time maps of ground motion and shaking intensity following significant earthquakes. The information, maps, and data available at this website provide ability to identify and estimate ground shaking levels associated with seismic events: http://earthquake.usgs.gov/earthquakes/shakemap/ | Add link to biblio, let viewers choose from there USGS task |
| add | 2. The Ground Water Protection Council remains active on coordinating and facilitating discussions across a variety of stakeholder groups, and has an internet site that provides publications on the topic to inform the public and stakeholders: http://www.gwpc.org/resources/publications | Add link to biblio, let viewers choose papers from there Link added |
| no | 3. Page K-4, General Information and Protocols Include reference to "White Paper II Summarizing a Special Session on Induced Seismicity" based on a special session entitled "Assessing & Managing Risk of Induced Seismicity by Underground Injection" held at the Ground Water Protection Council's 2013 Annual Forum, St. Louis (Sep 23-25). The white paper, authored by John Veil, is available at: http://www.gwpc.org/resources/publications | This is covered under the above (2) website See above |
| add | 4. Page K-10, West Virginia Include reference to Viso, R. F., "Sequential Development of the Gassaway Structure in Braxton County, West Virginia," West Virginia University, MSc. Thesis, 1999. | To biblio only |

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| Class | <p>Kris Nygaard <i>Oil/Gas Industry</i></p> | <p>EPA reviewer discussion notes: Consensus</p> |
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| <p>Add per final consensus</p> | <p>5. Page K-16, Protocols and Risk Analysis This section should include reference to the ExxonMobil paper that describes risk assessment, risk mitigation, and risk management of injection related induced seismicity (this paper is currently listed as reference on p. K-4 in the section “General Information and Protocols”, but would be better suited for listing as a reference in the “Protocols and Risk Analysis” reference section.</p> <p>a) Nygaard, K. J., J. Cardenas, P. P. Krishna, T. K. Ellison, and E. L. Templeton-Barrett, 2013, “Technical Consideration Associated with Risk Management of Potential Induced Seismicity in Injection Operations”, 5to. Congreso de Producción y Desarrollo de Reservas, Argentina, May 21 -24, 2013.</p> <p>b) To improve the clarity, usefulness, and ease of access of the reference listing, the “General Information and Protocols” section (p. K-4) should be re-labeled as “General Information” and all “protocol-related” references should appear listed in the Protocols and Risk Analysis Section (p. K-15). This will help the reader more readily identify relevant reference sources specifically related to risk management.</p> | <p>Propose adding all peer reviewer recommendations to one section, or the website for collections appearing under one group such as GWPC.</p> <p><u>Not added outside scope</u></p> |

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| <p>1. Page K-18, Technical or Technology Include the 2013 study that illustrates that the presence of a basal seal has a potentially important effect on reducing pressure increases in the crystalline basement, decreasing the risk of an induced seismic event.</p> <p>a) Zhang, Y., Person, M., Rupp, J., Ellett, K., Celia, M., Gable, C., Bowen, B., Evans, J., Bandilla, Mozley, P., Dewers, T., Elliot, T. Hydrogeologic controls on induced seismicity in crystalline basement rocks due to fluid injections into basal reservoirs. Groundwater, NGWA, June, 2013. Paper available at: Zhang, Y., Person, M., Rupp, J., Ellett, K., Celia, M., Gable, C., Bowen, B., Evans, J., Bandilla, Mozley, P., Dewers, T., Elliot, T. Hydrogeologic controls on induced seismicity in crystalline basement rocks due to fluid injections into basal reservoirs. Groundwater, NGWA, June, 2013.</p> <p>b) Include the recent study has been published in 2014 that illustrates that the subsurface complexity and that many factors may lead to induced seismicity Amos C.B., Audet, P., Hammond, W.C., Burgmann, R., Johanson, I.A., Blewitt, G. (2014) "Uplift and seismicity driven by groundwater depletion in central California", Nature 509, 483–486 (May 22). Paper available at: http://www.nature.com/nature/journal/v509/n7501/full/nature13275.html</p> <p>c) Include references that describe ground shaking relationships associated with seismic events, specifically, two key references are: Wald, D. J., Quitoriano, V., Heaton, T. H., Kanamori, H. (1999) "Relationships between peak ground acceleration, peak ground velocity, and modified mercalli intensity in California", Earthquake Spectra, 15: 557 – 564</p> <p>Wald, D. J., Worden, B. C., Quitoriano, V., and Pankow, K. L., Advanced National Seismic System, "ShakeMap® Manual, Technical Manual, Users Guide, and Software Guide", Version 1.0 (June 19, 2006). Available from the USGS at: http://pubs.usgs.gov/tm/2005/12A01/pdf/508TM12-A1.pdf</p> | <p><u>Last reference can be linked through GWPC web link, not specifically cited</u></p> |
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| Class | <p>Kris Nygaard <i>Oil/Gas Industry</i></p> | <p>EPA reviewer discussion notes: Consensus</p> |
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| | <p>2. A second “white paper” that summarizes the status of knowledge and approaches for assessing and managing the risk of induced seismicity, has been developed based on a special session entitled “Assessing & Managing Risk of Induced Seismicity by Underground Injection” held at the Ground Water Protection Council’s 2013 Annual Forum, St. Louis (Sep 23-25). The white paper, authored by John Veil, is available at: White Paper II Summarizing a Special Session on Induced Seismicity</p> <p>.....etc etc etc</p> | |
| <p>clarify</p> | <p>Appendix M: USGS Collaboration</p> <p>a) The USGS has developed an informative and substantial body of literature and information on ground shaking levels associated with seismic events, and the correlation of ground shaking values (e.g., PGA / PGV values) to the Modified Mercalli Scale and other magnitude scales. There is significant omission in the draft report that this information is not effectively summarized in the main body of the report or Appendix M.</p> <p>b) Informing the UIC regulators, stakeholders, and broad public on the actual ground shaking levels that may be expected with publicly reported magnitudes from monitoring systems is critical to ensure proper understanding of the hazard. Appendix M and/or the main body of the report should be revised to provide a summary of the information developed by the USGS related to ground shaking characterization and correlation of ground-shaking metrics to magnitude measurements. The type of detailed information is readily available on the USGS website and could be readily included in the current report.</p> <p>http://earthquake.usgs.gov/earthquakes/shakemap/background.php http://earthquake.usgs.gov/learn/topics/mag_vs_int.php</p> | <p>Clarify USGS participation</p> |

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Comments by Heather Savage, Academic Laboratory

| Class | Heather Savage <i>Academic Laboratory</i> | EPA reviewer discussion notes: Consensus |
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| | 1. I think that all of the appropriate data sources have been identified. | Thank you. |

Comments by Ed Steele, Oil/Gas Industry and Consultant

| Class | Ed Steele <i>Oil/Gas Industry and Consultant</i> | EPA reviewer discussion notes: Consensus |
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| Add peer reviewed to biblio | <p>1. In any such undertaking that transpires over an extended length of time, there will inevitably be publication of new research that can provide value for consideration. As academic and industry interest in induced seismicity has risen, there has been a concomitant increase in workshop, conferences, and symposia dedicated to this subject. As such, any point-in-time exercise as the NTW effort should provide recommendations way forward that are flexible enough to consider the findings from additional research and studies.</p> <p>Additional Selected Suggest References:</p> <p>McGarr, A 2014, Maximum magnitude earthquakes induced by fluid injection, <i>Journal of Geophysical Research: Solid Earth</i>, American Geophysical Union.</p> <p>Costain, J.K, G.A. Bollinger and J. A. Speer 1987, Hydroseismicity – A hypothesis for the role of water in the generation of intraplate seismicity, <i>Geology</i> v. 15, pp. 618-621.</p> <p>Costain, John K. and G.A. Bollinger 2010, Review: Research Results in Hydroseismicity from 1987 to 2009, <i>Bulletin of the Seismological Society of America</i>, vol. 100, No. 5A, pp. 1841-1858.</p> | Add to biblio as above—if peer reviewed |

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| Class | <p>Ed Steele</p> <p><i>Oil/Gas Industry and Consultant</i></p> | <p>EPA reviewer discussion notes: Consensus</p> |
|------------------------------------|---|--|
| <p>Add peer reviewed to biblio</p> | <p>Simpson, D.W., W.S. Leith and C.H. Scholz 1988, Two Types of Reservoir Induced Seismicity, Bulletin of the Seismological Society of America, vol. 78, No. 6, pp. 2025-2040.</p> | <p>Add to biblio as above—if peer reviewed</p> |
| | <p>Talwani, Pradeep 1997, On the Nature of Reservoir Induced Seismicity, Pure and Applied Geophysics 150, pp. 473-492.</p> | |
| | <p>Flewelling, Samuel A. and Manu Sharma 2014, Constraints on Upward Migration of Hydraulic Fracturing Fluid and Brine, Groundwater, Vol. 52, No. 1, pp. 9-19.</p> | |
| | <p>Zoback, M.D. et al 2003, Determination of stress orientation and magnitude in deep wells, International Journal of Rock Mechanics and Mining Sciences 40, pp. 1049-1076.</p> | |
| | <p>Galybin, A.N., S.S. Grigoryan and Sh. A. Mukhamedev 1998, Model of induced seismicity by water injection, SPE/ISRM 47253.</p> | |
| | <p>Hurd, Owen and Mark D. Zoback 2012, Intraplate earthquakes, regional stress and fault mechanics in the Central and Eastern U.S. and Southeastern Canada, Tectonophysics 581, pp. 182-193</p> | |
| | <p>Bonilla, M.G., R.K. Mark and J.J. Lienkaemper 1984, Statistical Relations Among Earthquake Magnitude, Surface Rupture Length, and Surface Fault Displacement, USGS Open-File Report 84-256, Version 1.1.</p> | |
| | <p>Rutqvist, Jonny, et al, 2013, Modeling of Fault Reactivation and Induced Seismicity During Hydraulic Fracturing of Shale Gas Reservoirs, Journal of Petroleum Science and Technology 107, pp. 31-44.</p> | |

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| Class | Ed Steele <i>Oil/Gas Industry and Consultant</i> | EPA reviewer discussion notes: Consensus |
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| Clarify | 4.10 Appendix I: Aseismic Examples Is there a reason why the wells involved in the examples cited are not named and located? This could be helpful if someone had more information to add and the information provided is not consistent in form with the case studies. | |
| Clarify | 4.11 Appendix J: Paradox Valley There is a wealth of information available that could have been provided here. Is there any reason why this section was kept so brief? | Clarify – as stated in comment, there is already a wealth of data, no need to repeat here |